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Toward a fifteen battlegroup navy: a supply side view and implications for force composition and personnel quality

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THESIS

TOWARD A FIFTEEN BATTLEGROUP NAVY: A SUPPLY SIDE VIEW AND IMPLICATIONS FOR FORCE COMPOSITION AND PERSONNEL QUALITY

by

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and

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This thesis develops a methodology for addressing the personnel supplies necessary to meet the manpower requirements of the 15 battlegroup Navy. The methodology utilizes cross-sectional data, a Markov chain transitional flow model, projections of future Navy enlisted force levels, and economic and demographic conditions to derive required annual inputs and the numbers of qualified individuals available to satisfy the input requirements. The effects of varied retention rates and the values of selected economic and policy related variables are analyzed in terms of input numbers required and policy implications. Analysis reveals that, though sufficient numbers of input personnel are available, the overall quality of these individuals may be inadequate to meet the increasingly technical demands of the 1980's. Further, although the outlook is favorable for reducing the present petty officer shortfall by 1990, the by-paygrade profile of petty officers may reveal significant imbalances between junior and senior grades.

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I. INTRODUCTION AND BACKGROUND

A. INTRODUCTION

In policy statements over the past year, the Reagan Administration has committed the Nation to a naval strategy based on the development of a fifteen battlegroup Navy by 1990. Without arguing the exact composition of a battlegroup, achievement of the fifteen battlegroup goal will mean an operational fleet of some 600-plus combat and support ships. This goal is achievable if Congress is willing to commit the fiscal, industrial, and labor resources necessary to bring it about. Though it may be possible to put 600 ships to sea, it may be quite another to man them adequately with the type of sailor capable of the safe and effective operation of these ships.

This thesis examines the questions of manning, with the necessary enlisted personnel, a growing Navy, from 1982 through 1990. What are the annual end strength requirements? What are the requisite annual accession levels to meet these end strengths? What sources of supply and how much of each will be available to fill the accession requirements? And most importantly, are those sources of supply which are available sufficient to meet the demands of the proposed fleet expansion? A methodology is applied which attempts to answer these and other questions by making use of a

computerized computational manpower transitional flow model, an enlistment supply model, and pertinent demographic, policy, and economic information.

First, there is a brief examination of the manpower requirements upon which annual authorization figures are based. These authorizations represent the end strengths which must be met through accessions and personnel movement through the manpower system in that particular year. The annual accession figure is the output of a manpower transitional flow model which uses beginning inventories, end strengths, and personnel movement data as inputs. The accession figures are then examined with regard to the sources of supply available to fill the accession requirements. In recognition that non-prior service (NPS) males are the most important source of supply, an enlistment supply model is used to forecast the number of NPS males available to fill all or part of the requirements. Finally, other sources of supply are considered to fill the remaining requirements, and an analysis is done to determine the adequacy of the accessions in meeting the Navy's needs.

The models used allow a great deal of flexibility in simulating system response to actual, projected, or desired conditions. As such, they permit an unlimited number of "what if?" scenarios responding to any particular variable of interest. This thesis presents three such scenarios.

The first examines a baseline case reflecting current economic forecasts and projected policy standards. A second scenario examines the shortage of petty officers and determines a set of annual first and second term and career retention rates necessary to eliminate the aggregate petty officer shortfall by 1990. The final scenario focuses on the Navy's ability to fill the requirements for quality personnel in its highly technical ratings.

The following section of this chapter provides a brief synopsis of the Navy's sources of manpower supplies and some factors affecting those supplies. This is followed by an introduction to the two models used in the scenario calculations: the manpower transitional flow model and the enlistment supply model. The next chapter explains, in detail, the methodology employed in the accession and supply determination process. Chapter III applies the methodology of Chapter II to the conditions of each of the three scenarios and presents the results. The thesis concludes in Chapter IV with a summary, a discussion of policy implications, and suggestions for further areas of study.

B. BACKGROUND

1. Sources of Supply

There are seven major potential sources of manpower supply for the Navy. Some of these make up the group of direct accessions each year, others fill billets through

other means, thereby lessening the demand for normal accessions. The following represents a brief synopsis of these sources and a discussion of some factors affecting manpower supplies of the 1980's.

a. Non-Prior Service Males

The primary and preferable source of supply is the pool of non-prior service, high school diploma graduate, upper mental category males, ages 17-21. The non-prior service male has traditionally provided the core of annual accessions and is expected to continue to do so through the 1980's. High school diploma graduates are desired, as their attrition rates during the 1970's were approximately one-half of the attrition rates for non-high school diploma graduates. [Ref. 1]

The upper mental category or high quality individual is desired for his ability to meet the technical education and skill requirement of many Navy jobs. Additionally, lower quality individuals are more likely to be involved in disciplinary actions. Mental category groupings, as shown in Table 1, reflect percentile scores on the general aptitude portions of the Armed Services Vocational Aptitude Battery (ASVAB). Mental categories I and II are considered above average, mental category III average, mental category IV below average, and mental category V not legally recruitable. [Ref. 2] Unfortunately, in the 1980's, a growing Navy will be drawing its non-prior service

male resources from a declining pool of manpower. How well the numbers required can be met by the numbers available is a major focus of this thesis.

TABLE 1

Mental Categories

Mental Category	Percentile Score
I	93-99
II	65-92
IIIA	50-64
IIIB	31-49
IVA	21-30
IVB	16-20
IVC	10-15
V	01-09

b. Women

In 1981, the Navy brought in 9,700 toward reaching a female end strength of 34,300. Current plans from the Navy's Enlisted Women's Utilization Study call for an increase in end strength to 45,000 by 1985, or 8.4% of the active duty enlisted force, supported by a projected 10,400 annual accessions. While potential for growth in utilization of women exists, it is constrained by several factors, including Navy-wide sea/shore rotation, upward mobility and acceptable career paths for women, and

statutory restrictions. The U.S. Code, Title 10, Section 6015 prohibits the permanent assignment of women to units having a combat mission. As thirteen of the Navy's 100 enlisted occupational specialties are found almost exclusively aboard combat units, they are not available to women. [Ref. 3] Subject to existing constraints, the Navy has not yet tapped the limit of available and interested recruitable women. [Ref. 4] Though the potential exists for increased accessions, the 10,400 accessions figure will be used in accession projections found later in Chapter III.

c. Retention

One of the best ways to fill billet requirements is with the personnel who are already occupying those billets. Retaining an individual eases the pressure to bring in, train, and age (give experience to) a replacement. Aside from the time necessary for an individual to gain the requisite experience, replacement costs can be as high as $79,000 per individual. [Ref. 5]

Another implication of increased retention is the higher career to first term personnel mix, which may have several positive effects. Firstly, a reduced demand for accessions would result, which would in turn allow the Navy to rely less heavily upon lower mental group and non-high school diploma graduates. Secondly, on the average, careerists are more productive than first-termers, and the total per-individual cost of each is very similar.

Consequently, careerists are less costly per unit of productive output than first term personnel. Finally, with fewer demands placed on the first-termer, he can be more readily assigned to a job for which he is suited, thereby raising his productivity. All of these factors are capable of saving the Navy as much as $2.8 billion in the late 1980's, and can result in a substitution ratio of as much as 340 first-termers to 100 careerists. [Ref. 2]

Retention rates are a measure of the number of members who continue in service beyond their current obligated service, as opposed to reenlistment rates which are a measure of those who continue, out of those who are eligible to do so. Retention rates for personnel at first term, second term, and career decision points in 1981 were 42%, 57%, and 94%, respectively. The Navy's POM 83 retention goals are 47%/67%/98%, and are treated as a constant in two of the three scenarios run later in this thesis.

d. Prior Service Lateral Entry

Prior service accessions, whether Navy Veterans (NAVETs) or Other Service Veterans (OSVETs), are a major supply source similar to retention. The major differences are that the individuals have left the service and, in some form, must be reprocessed for entry, and that the Navy is able to draw on experienced personnel who have left other services. Additionally, the pool of eligible prior service enlistees is considerably larger than the numbers of

in-service personnel becoming eligible for reenlistment on a continuing basis. During times of weak economic conditions, the pool of interested and recruitable prior service members swells and the Navy is able to pick the individuals needed to fill individual critical shortages in the petty officer ranks. In 1981, the Navy brought in 12,314 prior service personnel, three-fourths of whom were Navy veterans. The POM 83 projection of 12,000 annual prior service accessions is utilized in the computations in this thesis.

e. Civilian Lateral Entry

The Navy appears to continually train personnel for employment in the civilian sector. What is seldom considered is that civilian industry can be viewed as a training ground for individuals for potential employment in the Navy. In many instances, technical and vocational schools, and industry itself, are training individuals in skills such as welding, machine operation and repair, construction, etc., which are readily transferable to Navy jobs. Where shortages for these skills exist, it might be worth recruiting a civilian with the requisite skills and experience into the position. The biggest drawbacks exist in expecting a civilian lateral entrant into a relatively senior rate to perform satisfactorily as a petty officer and a supervisor in the unfamiliar Navy environment. Little in the way of civilian lateral entry has been done in recent years, and in 1981 there was a total of only 60 accessions

brought in through this program. However, the Navy Personnel and Development Center (NPRDC) is overseeing the development of the Lateral Entry Accession Program (LEAP). LEAP in its trial phases is focusing on the thirteen ratings shown in Table 2, ratings whose skill requirements most readily lend themselves to civilian lateral entry. As civilian lateral entry is in the developmental stages, and few near-term accessions are anticipated, this source of supply is not considered in the supply-demand scenarios analyzed in this thesis.

TABLE 2

Ratings Under Consideration for Civilian Lateral Entry

AE	EN	IM	MS	YN
AT	ET	MM	SK	
EM	HT	MR	ST	

Source: NPRDC

f. Civilian Substitution

Civilian employees of the Navy traditionally have provided a large source of manpower supply, especially in the support areas and shore establishment. At the end of 1981, there were just over 320,000 civilians employed by the Navy, and the potential exists for further utilization, particularly in readiness related activities such as shipyards, intermediate maintenance activities (IMAs), and

supply centers. Military sea/shore rotation would have to be a consideration in any plans for expansion. The further expansion of the Federal civilian work force is unlikely, however. The Office of Management and Budget (OMB) established employment ceilings in order to administer Presidential employment ceiling limitations. At the end of 1981, Department of the Navy (Navy and Marine Corps) civilian employment was at 100% of OMB guidelines. [Ref. 6] Although near-future growth of civilian employment is unlikely, expanded manpower supply is very possible through the Commercial Activities Program for contracting out services. Established to achieve budgetary efficiencies through contracting out, when the contracted services are less expensive than direct hire, this program does have growth potential. Because the area of civilian substitution is in transition, it is not considered in the scenario projections.

g. Reserves

Coupled with the expansion of the Total Force Navy is the expansion of the Naval Reserve. There were 88,000 paid drilling Selected Reservists and 12,000 full-time active-duty Reservists ("TARS") serving at the end of 1981. Between FY 82 and FY 86, twelve KNOX-class frigates will be transferred to the Naval Reserve Force. Though the 1983 Navy Manpower Mobilization System (NAMMOS) manpower requirement is 113,000, only 93,000 reservists are requested

for 1983. Because of its expansion requirements and the current personnel shortfalls, the Naval Reserve, in effect, will be competing for the same resources desired by the active force. Therefore, utilization of reserve sailors on active duty, beyond the employment of TARS, is unlikely and no consideration is given to them in the scenarios.

h. Factors Affecting Manpower Supplies

The amount and type of manpower resources which are available are affected by various factors, some of which are controllable and others which are not.

The number of non-prior service males available is directly and adversely affected by the demographic reality that there will be a 15-17% decline from 1982 to 1990, in the pool of eligible 17-21 year-old non-prior service males. Although the economy is currently favorable for recruiting, forecasts predict an improving economy, lower youth employment, and therefore increased recruiting competition. Industry is requiring more and more technically skilled individuals, and is apparently willing to pay for them. It will be increasingly difficult to retain trained sailors without the Navy making a more attractive offer inducing them to stay. The Navy is also in competition with the educational system and the desire of colleges to attract the same 17-21 year-old high school diploma graduate targeted by the Navy. Congress has imposed a ceiling on mental category IV accessions, limiting them to 25% of

FY 82 accessions, and 20% of total accessions for FY 83 and beyond. As these restrictions apply to all services, there will be increased inter-service competition for the quality accession. Finally, the increasing technical complexity of Navy hardware systems will increase the demand for the quality individual who is capable of being trained in the operation and maintenance of these systems.

2. Markov Chain Transitional Flow Model

The Markov Chain Transitional Flow Model is a mathematical model which describes the flow of personnel through an organizational paygrade system. The elements of the model are the personnel inventories in the system at the beginning of the year, the accessions entering the system during the year, the percentage by-paygrade profile of the entering accessions, the end strengths at the end of the year, and the transitional flow matrix which reflects the movement of personnel through the system during the year. Movement through the system refers to an individual's transition from his paygrade at the beginning of the year to his status at the end of the year. That transition may be to a higher paygrade, to a lower paygrade, remaining in the same paygrade, or exiting the system.

The transitional flow model is capable of generating either accessions or end strengths as the output, depending on the input. Given beginning inventories, accessions, and the transition matrix, it will produce the end strengths

for the end of the year. Given the desired end strengths, beginning inventories, accession by-paygrade profile, and transition matrix, it will produce the necessary accessions, by paygrade. This later approach is utilized in the three scenarios to determine the annual accession requirements based on predetermined end strengths or authorizations.

3. Enlistment Supply Models

Projections of the number of available non-prior service males are a key element in the determination of the composition of accessions in the outyears. The three major enlistment supply models are those known as the Rand, CNA, and Duke models. An excellent comparison of these three models is found in "Department of Defense and Navy Personnel Supply Models: Report of a Workshop."

a. The Rand Model

The Rand model is a linear enlistment supply model developed by Fernandez, and reported in "Forecasting Enlisted Supply: Projections for 1979-1990." This model is actually a series of service-specific models for non-prior service (NPS) male high school diploma graduates (HSDG), in each of three mental category groupings (mental categories I and II, mental category IIIA, and mental category IIIB).

The dependent variable in each model is the NPS male HSDG enlistment rate. The independent variables are relative military/civilian pay, the number of production

recruiters, and a youth unemployment rate. In the development of the model, the unemployment rate was for 16-19 year-olds, seasonally adjusted, and lagged a year. This lagging feature is unique to this model. The military/civilian pay ratio is a measure of the average first year regular military compensation (RMC) for enlistees with less than two years of service divided by the average weekly earnings in the total economy.

Monthly observations on all variables from July 1970 to September 1978 were used in estimating the models. Because of the availability for the explanatory variables and its provision of DOD-wide results for comparisons in collateral study, this model is used for NPS male supply determination in Chapter III, where its results are detailed and its use explained.

b. The Duke Model

The enlistment supply model known as the Duke model was developed by Morey at Duke University and reported in "Budget Allocation and Enlistment Prediction Models for the Navy's Recruiting Command: Testing and Validation." This model is actually two separate supply models, one developed for all Navy non-prior service (NPS) male high school diploma graduates (HSDG), and a second developed for Navy NPS male HSDG's in mental categories I-IIIA.

The Duke model is a multiplicative model based on monthly data for the period January 1976 through

through September 1979 from the 43 Navy Recruiting districts. The dependent variable is the number of Navy enlistments for each of the two groups. The explanatory variables are the number of Navy recruiters, a ratio of regular military compensation to average first year civilian earnings, unemployment rate, percent black, percent urban/rural, and several advertising variables measuring the extent of the various forms of advertising. [Ref. 7] Although it is a predictive model, the Duke model focuses on the process of resource allocation in the management of recruiting, and has been adopted by the Navy Recruiting Command for that purpose. [Ref. 8]

c. The Center for Naval Analyses (CNA) Model

The CNA model was developed by Goldberg and was reported in "Recruiters, Advertising, and Navy Enlistment." It is composed of three separate multiplicative enlistment supply models, one for all non-prior service (NPS) male high school diploma graduates (HSDG), a second for NPS male HSDG's in mental categories I and II, and a third for NPS male HSDG's in mental category IIIA.

The dependent variable is the number of NPS male HSDG enlistments per population for each of the respective mental category groupings. Explanatory variables are relative civilian/military pay, unemployment, the 17-21 year-old population pool, each service's recruiters per population, percent black, a G.I. Bill dummy variable, and

the expenditures for Employment and Training Administration (ETA) programs per population of 17-21 year-old males in each recruiting district. The relative civilian/military pay was expressed as the average full-time earnings of 18 year-old civilian males divided by the first year's regular military compensation. The ETA expenditures were represented by two variables, one for youth programs, the other for countercyclical programs. The CNA model was based on annual data from October 1975 through September 1980 for the 43 Navy Recruiting Districts. This model is considered to be the strongest of the three models predicting Navy enlistments. [Ref. 8] And, as it has been recently updated, it should receive first consideration for future work concerning projected Navy enlistments.

II. METHODOLOGY

As discussed earlier, the methodology employed in this thesis follows a sequence of processes beginning with billet requirements determination, followed by determination of accessions needed to keep those billets filled (given specified retention rates), and ending with an assessment of the Navy's ability to supply the required accessions. This chapter will detail each of these processes without use of specific data.

A. REQUIREMENTS DETERMINATION

In June, 1981, an unpublished method for aggregate manpower requirements determination was suggested by a group of officer-students in the Manpower, Personnel, and Training Analysis curriculum at the Naval Postgraduate School. This method is outlined below and is used as a point of departure for the requirements figures used in subsequent calculations.

The first step in the billet requirements process is the development of a fleet composition profile detailing the numbers and types of deployable ships, by year, from 1982 to 1990, necessary to achieve fifteen battlegroup strength by 1990. This was done, for each year, by taking the year's beginning ship inventory, adding to it the ships to be introduced into the fleet during the year and

subtracting the ships expected to leave service during the year. This projected force profile is shown in Table 3. Similarly, airwing strengths for each year were projected to support the aircraft requirements of the air-capable ships in service during that year.

The next step was the conversion of the annual unit requirements into enlisted billet requirements. For the ships, this was accomplished by means of the Ship Manning Document (SMD), and for aviation units by means of the Squadron Manning Document (SQMD). The SMD and SQMD detail, by paygrade, rating, and Navy Enlisted Classification (NEC) Code, the numbers of personnel needed to operate the unit so it will fulfill its mission. Each ship, or ship class, and each aviation squadron has an SMD or SQMD fitted to the billet requirements of that unit. Accordingly, each ship or aviation unit identified with a particular year in the force profile has an SMD or SQMD associated with it. Therefore, the annual force billet requirements can be expressed as the sum of the SMD or SQMD requirements for the applicable units. Tables 4 and 5 are the annual enlisted billet requirements for ships and aviation units respectively.

Projected shore-based billet requirements are not as easy to determine. The shore establishment equivalent of the SMD and SQMD is the Shore Requirements, Standards, and Manpower Planning System (SHORSTAMPS), which determines requirements for military and civilian manpower in the shore

TABLE 3

1981-1990 600 Ship "Deployable" Status

	FY81	FY82	FY83	FY84	FY85	FY86	FY87	FY88	FY89	FY90
CV/CVN[1]	13	14	14	14	15[2]	16	16	16	16	16
BB			1	2	2	2	3	4	4	4
CG/CGN	27	28	29	30	32	35	38	41	43	45
DD/DDG's	82	83	84	84	84	82	82	84	86	86
FF/FFG's	79	79	85	91	96	98	103	108	113	113
SS/SSN[3]	92	98	103	107	109	109	109	109	112	112
SSBN	36	34	33	34	35	35	36	37	38	39
AMPHIB	63	63	63	63	63	62	63	63	63	63
UNREP	33	33	33	32	32	31	31	31	31	31
NAT SUPT	27	29	30	31	31	31	31	31	31	31
FLT SUPT	17	17	17	17	17	17	17	17	17	17
OTHER	8	11	11	11	13	15	21	29	37	37
TOTAL	477	489	503	516	529	550	567	587	608	611

Notes: [1] Includes CV in SLEP
[2] Adds ORISKANY
[3] Includes SSBN conversion

Source: Janes Fighting Ships 1980-81
US Naval Institute Proceedings
Jan 81

TABLE 4

Enlisted Ship Billets by Paygrade

Paygrade / FY	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90
E1-E3	75,514	77,245	78,360	79,880	80,412	83,182	85,997	86,182	86,590
E4	50,491	50,951	51,641	52,978	53,861	55,343	56,723	57,638	57,822
E5	35,399	36,257	36,890	37,549	38,332	39,376	40,344	41,168	41,507
E6	24,208	24,915	25,204	25,914	26,377	27,155	27,875	28,573	28,701
E7	10,304	10,577	10,702	10,982	11,269	11,429	11,708	11,947	12,118
E8	2,641	2,724	2,736	2,808	2,863	2,939	3,002	3,054	3,074
E9	1,154	1,186	1,199	1,225	1,231	1,259	1,304	1,321	1,329
Total	198,711	203,855	206,732	211,336	214,345	220,683	225,953	229,883	231,141

TABLE 5

Enlisted Squadron Billets
by Paygrade

Paygrade \ FY	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90
E1-E3	12,238	12,266	12,313	13,365	13,429	13,483	13,532	13,563	13,639
E4	6,616	6,633	6,661	6,689	7,263	7,294	7,324	7,350	7,377
E5	7,308	7,326	7,375	7,388	8,023	8,056	8,087	8,118	8,149
E6	3,788	3,798	3,815	3,831	4,161	4,179	4,195	4,212	4,228
E7	781	783	787	792	859	864	868	872	876
E8	635	635	635	635	689	689	689	689	689
E9	288	288	288	288	312	312	312	312	312
Total	31,654	31,729	31,856	31,988	34,736	34,877	35,007	35,116	35,270

establishment. However, only 35% of the shore establishment is currently covered, with 70% coverage projected by 1987. [Ref. 3] A further complicating factor is the fact that unlike the direct linkage between air-capable and required airwing support, there is no such specific linkage between the fleet and its shore support.

Presumably, the shore establishment must grow in order to meet the support needs of a growing fleet. This growth ashore will probably incorporate the ability to maintain a balanced sea/shore rotation. Because of the lack of complete billet requirements coverage by SHORSTAMPS, and the lack of a specific relationship between the fleet and the shore establishment, certain functional relationships are assumed. Shore support billets can be broken down into three groupings, manpower support, ships support, and training support. The manpower and training support are considered to be in direct relationship to the at-sea billet requirements determined earlier, and the ship support is considered to be in direct proportion to total ship tonnage. The sum of the three annual support requirement figures so derived produce an aggregate annual support requirements figure. A by-paygrade breakdown of these requirements is accomplished by applying the percentages of the 1981 unconstrained requirements to the annual aggregate figures. Enlisted support billet requirements for 1982-1990 are shown in Table 6, and total enlisted billet requirements, the sum of ship, aviation,

TABLE 6

Enlisted Support Billets
by Paygrade

Paygrade \ FY	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90
E1-E3	84,824	85,615	86,262	87,583	88,821	90,212	91,580	92,317	92,700
E4	50,839	51,312	51,700	52,491	53,234	54,067	54,887	55,329	55,559
E5	60,101	60,668	61,126	62,061	62,940	-3,924	64,894	65,416	65,688
E6	52,524	53,013	53,414	54,231	54,999	55,859	56,707	57,163	57,401
E7	23,032	23,347	23,422	23,780	24,117	24,494	24,866	25,066	25,170
E8	6,741	6,804	6,855	6,960	7,059	7,169	7,278	7,336	7,367
E9	2,809	2,835	2,856	2,900	2,941	2,987	3,032	3,057	3,070
Total	280,876	283,494	285,635	290,006	294,111	298,712	303,244	305,684	306,955

and support requirements, are shown in Table 7. These totals are unconstrained billet requirements and represent the projected requirements for a fully mission capable Navy.

As desirable as full mission capability may be, the manpower requirements to achieve it are in excess of the number of bunks and facilities available to support them. Consequently, Congressional manpower authorizations reflect bunk constrained figures. These bunk constrained figures, as reported in the Enlisted Programmed Authorizations, are the figures used as annual required end strengths in the accessions determination process. The Enlisted Programmed Authorizations cover the period from FY82 to FY86; the Navy further looks to a 560,000 figure in 1990. Authorizations or end strengths for FY 87, FY 88, and FY 89 reflect an assumption by the authors of constant growth from FY 86 through FY 90. The projected authorization figures for 1982-1990 appear in Table 8.

B. ACCESSIONS DETERMINATION - TRANSITIONAL FLOW MODEL

With the annual end strength requirements established, it is necessary, next, to determine the annual accessions necessary to achieve these end strengths. The link between end strengths and accessions is the manpower transitional flow model mentioned earlier. The elements of the model are the end strengths or stocks, the beginning personnel inventory or stocks, the accessions or flows in, and the

TABLE 7

Total Enlisted Billets
by Paygrade

Paygrade / FY	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90
E1-E3	171,576	175,126	176,935	179,828	182,662	186,877	190,109	192,062	192,929
E4	107,946	108,896	110,002	112,158	114,358	116,704	118,934	120,317	120,758
E5	102,814	104,251	105,373	106,998	109,295	111,356	113,325	114,702	115,344
E6	80,520	81,726	82,433	83,976	85,537	87,193	88,777	89,948	90,330
E7	34,117	34,607	34,911	35,554	36,245	36,787	37,-42	37,885	38,164
E8	10,017	10,163	10,226	10,403	10,611	10,797	10,969	11,079	11,130
E9	4,251	4,309	4,343	4,413	4,484	4,558	4,648	4,690	4,711
Total	511,241	519,078	524,223	533,330	543,192	554,272	564,204	570,683	573,366

TABLE 8

Enlisted Billet Authorizations

Fiscal Year	Authorization
82	480,149
83	504,874
84	516,285
85	528,381
86	534,081
87	540,561
88	547,041
89	553,520
90	560,000

Source: Enlisted Programmed Authorizations and Authors

transitional flow matrix. In natural sequence the relationship can be expressed by the equation

$$s(t) = f(t) + Qs(t-1) \qquad \text{EQ 1}$$

where

$s(t)$ = the stocks at the end of time period t or end strengths for the year,

$f(t)$ = the flows into the system during time period t or accessions during the year,

$s(t-1)$ = the stocks at the end of time period t-1 or the beginning inventory of the current year,

Q = the transitional flow matrix describing the movement of s(t-1) through the system during time period t, the current year.

For the calculations in this thesis, s(t), f(t), and s(t-1) are seven-element vectors and Q is a 7 x 7 matrix. These parts of the equation are explained in the following paragraphs.

s(t) is a N vector composed of i elements where $s_i(t)$ is the stock of personnel in paygrade i at time t; i=1,2,...N. In subsequent use N is equal to 7 and the subscript i depicts paygrade where i equals i+2, i.e., i=2 describes paygrade E4, i=3 describes paygrade E5,..., i=7 describes paygrade E9. i=1 describes the consolidated stocks for E1, E2, and E3. The vector for end strengths by paygrade is

$$S(t) = (S_1(t),\ S_2(t),\ S_3(t),\ S_4(t),\ S_5(t),\ S_6(t),\ S_7(t))$$

s(t-1), likewise, is a 1 x 7 row vector depicting the by-paygrade stocks at time t-1. The vector for end strengths by paygrade is

$$S(t-1) = (S_1(t-1), S_2(t-1), S_3(t-1), S_4(t-1), S_5(t-1), S_6(t-1), S_7(t-1))$$

f(t) is a 1 x 7 row vector, depicting the flows into the system during period t. $f_2(t)$ through $f_7(t)$ represents prior service accessions. The vector for accessions is

$$f(t) = (f_1(t),\ f_2(t),\ f_3(t),\ f_4(t),\ f_5(t),\ f_6(t),\ f_7(t))$$

Q is a 7 x 7 matrix illustrating the movement of personnel within a time period. The matrix partitions the stock of personnel in class i into fractions that flow into each class j, and is composed of q_{ji} elements where q_{ji} is the fraction of personnel that are in paygrade i at time t that are in paygrade j at time t+1. Each element q_{ji} describes the historical movement of personnel during one time period. For the calculations in this thesis, the Q matrix describes conditions of retention, attrition, and promotion, in 1981. As examples from the general matrix below, element q_{44} represents those personnel who remain in paygrade E6, and elements q_{54} represents those personnel who are promoted from E6 to E7 during the year.

$$Q = \begin{bmatrix} q_{11} & q_{21} & q_{31} & q_{41} & q_{51} & q_{61} & q_{71} \\ q_{12} & q_{22} & q_{32} & q_{42} & q_{52} & q_{62} & q_{72} \\ q_{13} & q_{23} & q_{33} & q_{43} & q_{53} & q_{63} & q_{73} \\ q_{14} & q_{24} & q_{34} & q_{44} & q_{54} & q_{64} & q_{74} \\ q_{15} & q_{25} & q_{35} & q_{45} & q_{55} & q_{65} & q_{75} \\ q_{16} & q_{26} & q_{36} & q_{46} & q_{56} & q_{66} & q_{76} \\ q_{17} & q_{27} & q_{37} & q_{47} & q_{57} & q_{67} & q_{77} \end{bmatrix}$$

Equation 1 describes the basic process of the transitional flow model. Stocks for a given period t, s(t), may be determined by adding the periods flows, f(t), to the product of the transitional flow matrix, Q, and the stocks from period t-1, s(t-1). This is a cross-sectional model in that it does not account for personnel or flows prior to time t-1 and only uses time t-1 data in the matrix. An assumption must be made that the movements reflected in the matrix for time t-1 are constant and will accurately represent the behavior of the system in later periods.

For the purpose of the calculations, it is more useful to consider the process described in equation 1, not in terms of the flows determining the stocks at time t, but rather as the requirement for certain stocks at time t dictating the necessary flows into the system during period t. Replacing vector s(t) with a vector r(t), denoting requirements, equation 1 can be rewritten as

$$f(t) = r(t) - Qs(t-1) \qquad \text{EQ 2}$$

Finally, it is desirable to be able to structure the distribution into the elements of f(t). To do so, f(t) can be thought of as the product of an aggregate flow into all paygrades and a vector of percentages summing to 1, determining the desired allocation. In order for the output of the model to be a set of flows conforming to the distribution

vector, r(t) must be an aggregate figure, not constrained by paygrade requirements. Equation 2, thus modified, is used to determine flows or accessions for each year based on aggregate annual requirements or authorizations. The results of this application are found in Chapter III.

C. SUPPLY ADEQUACY - ENLISTMENT SUPPLY MODEL

Once the accession requirements for a given year have been calculated, it is necessary to determine the ability of the sources of supply mentioned earlier to adequately meet the requirements. Under the conditions of section I.B, accession requirements are to be satisfied with a combination of upper mental group non-prior service (NPS) males, prior service males, women, and if necessary, mental category IV NPS males. The latter group is considered only after the exhaustion of available accessions from the other three sources. As prior service and women accessions are held constant on an annual basis at 12,000 and 10,400 respectively, the need for mental category IV NPS male accessions becomes a function of the availability of NPS males, mental categories I, II, and III. The key, then, is the determination of available upper mental category NPS males, and that is accomplished by the use of the enlistment supply model.

The particular model used is the Rand model, which predicts the expected enlistments of NPS male high school diploma graduates for each of mental categories I and II,

IIIA, and IIIB, as a function of the available pool, the military/civilian pay ratio, production recruiters, and the unemployment rate for 16-19 year-old males. The available pool consists of NPS male civilians age 17-21. The military/civilian pay ratio is defined as the average first year regular military compensation for enlistees with less than two years of service divided by the average weekly earnings in the total private economy. The youth unemployment rate was determined by Fernandez to be related to the general unemployment rate as in the following equation:

$$SA1619 = 5.695 + 1.712 SA16P \qquad \text{EQ 3}$$

where:

SA1619 = unemployment rate for males age 16-19, seasonally adjusted,

SA16P = unemployment rate for all workers, age 16 and over, seasonally adjusted.

A basic form of the enlistment supply model as applied to the Navy is:

$$E_t/POOL_t = a_o + b(MP_t/CP_t) + cRECR_t + dU_t \qquad \text{EQ 4}$$

where

E_t = voluntary enlistment in period t;

$POOL_t$ = NPS male civilians, age 17-21, at time t, in thousands;

MP_t = military pay at time t as defined earlier;

CP_t = civilian pay at time t as defined earlier;

$RECR_t$ = number of production Navy recruiters at time t;

U_t = unemployment rate for males, age 16-19, at time t;

a_o = regression constant;

b,c,d = regression weights for variables MP/CP, RECR, and U, respectively.

Regression coefficients for the explanatory variables for each mental category grouping are listed in Table 9.

With the use of Fernandez figures for E_{1981} and $POOL_{1981}$, 1981 data for the explanatory variables, and the regression coefficients for the explanatory variables, the constant a can be calculated for each mental category grouping. These constants are also listed in Table 9. The projected NPS male enlistments for a particular year can, then, be calculated by applying to the model the figures from Table 9 and the expected values of the explanatory variables for that year. Table 10 lists the anticipated enlistments for each year and by mental category, based on both moderate and high economic growth scenarios. The underlying assumptions leading to these results are detailed in Chapter III.

The final step in determining the adequacy of the available sources of supply is the comparison of required accessions with the available sources. If, for example, for a given year the accession requirements are 87,000 and the predicted NPS male mental category I, II, and III accessions are 46,000 the necessary input of mental category IV

TABLE 9

Enlistment Supply Model Results Summary

(Data are regression coefficients; the square of the multiple correlation coefficient, R^2; and the regression constant, a_o.)

Variable	Mental Categories I & II	IIIA	IIIB
Recruiters	- -	.1259	.1235
Relative Pay	14.61	-.30	4.52
Unemployment	49.56	29.12	27.83
R^2	.88	.919	.914
a_o	-.4805	-.2385	-.446

Source: Fernandez and Authors

NPS males would be 18,600 (87,000 required - 12,000 prior service - 10,400 women - 46,000 upper mental category NPS males = 18,600 NPS males, mental category IV). The 18,600 figure for mental category IV accessions should be a cause for concern, as 18,600 is 21.4% of the 87,000 required accessions, 1.4% higher than the 20% Congressional mandate for mental category IV accessions in FY 83 and beyond. Therefore, as in the comparisons in Chapter III, the measure of the adequacy of manpower supply is whether or not an acceptably high number of mental category IV personnel are needed to fill accession requirements.

TABLE 10

Enlistment Supply Projections 1982-1990

Moderate Economic Growth

(8.9% to 6.5% declining unemployment)

(Data are numbers of NPS male Navy enlistees.)

	Mental Categories			
Year	I & II	IIIA	IIIB	Total
1982	30,615	20,488	19,595	70,698
1983	27,738	18,874	18,055	64,667
1984	25,373	17,525	16,769	59,667
1985	24,110	16,831	16,108	57,049
1986	22,908	16,191	15,499	54,599
1987	22,420	16,012	15,332	53,764
1988	22,133	15,991	15,315	53,439
1989	22,084	16,085	15,408	53,577
1990	21,521	15,802	15,140	52,463

High Economic Growth

(8.0% to 5.0% declining unemployment)

	Mental Categories			
Year	I & II	IIIA	IIIB	Total
1982	28,549	19,274	18,435	66,258
1983	25,535	17,579	16,818	59,932
1984	22,423	15,792	15,113	53,328
1985	19,600	14,181	13,576	47,357
1986	19,126	13,968	13,375	46,469
1987	18,974	13,988	13,397	46,359
1988	19,080	14,196	13,600	46,876
1989	19,037	14,295	13,697	47,029
1990	18,552	14,057	13,472	46,081

D. SPECIFIC CASE MODIFICATIONS

The processes detailed in the previous three sections contain the basic methodology used in each of the three scenarios in Chapter III. However, each case does have modifications to the basic approach.

1. Baseline Scenario

The Baseline or aggregate scenario differs from the basic approach in two respects. Whereas the Q matrix to be derived in the first section of the next chapter reflects the movement of personnel in the system in 1981, the matrix used in the scenario is adjusted to reflect POM 83 retention goals. POM 83 goals are 47%/67%/98%, while the actual 1981 retention figures were 42%/57%/94%. The method for adjusting the matrix is explained following its derivation.

Secondly, the accession distribution vector, also called the recruitment vector, is adjusted as necessary to produce a total of 12,000 prior service accessions in flow elements $f_2(t)$ through $f_7(t)$. This process is described later as well.

2. Petty Officer Shortfall Scenario

In the Petty Officer Shortfall scenario, the same adjustments for prior service accessions, as mentioned for the Baseline case in the preceding paragraph, are necessary. Additionally, various changes are made to the matrix to reflect the specific retention rates necessary to achieve

the optimal stock levels and requirements elements $r_2(t)$ through $r_7(t)$.

3. Quality Scenario

In the Quality scenario, the authorization figures of Table 8 are not used. Instead, the total authorizations, from the Enlisted Programmed Authorizations, for personnel in the highly technical ratings are used. Additionally, these authorizations or requirements are increased at a greater than Navy-wide expansion rate to reflect the expected increased need for technically capable personnel. Finally, accession comparisons deal specifically with the numbers of mental category I and II personnel who are needed to man the highly technical ratings.

III. ACCESSION REQUIREMENTS AND SUPPLY DETERMINATION 1982-1990

This chapter uses specific data in the manpower modeling methodology presented in the previous chapter, and reports the results of calculations for three Navy enlisted manpower supply-demand scenarios.

A. TRANSITIONAL FLOW MODEL ELEMENTS

The transitional flow model consists of the transitional flow matrix, end strength requirements, beginning inventories, the recruitment vector, and accessions for the year as described, in general, in Chapter II. These elements were given values for specific data for scenario calculations, as related in the following paragraphs.

1. Transitional Flow Matrix

The transitional flow matrix (Q) describes the movement of personnel in the system during the year, as a reflection of attrition, retention, and promotion conditions for that year. The matrix developed below, and used in subsequent calculations, is based on 1981 behavior data provided by the Defense Manpower Data Center (DMDC), and describes behavior by personnel in the system during that year only. Behavior of personnel in the system in prior years is not taken into account. Recognizing that the matrix is based on point-in-time data, an assumption was made that

the matrix would reflect system behavior in subsequent years through 1990.

The first step in the development of the Q matrix is the establishment of a personnel data matrix which shows the number of personnel in each matrix element, e.g., the number of personnel beginning the year in paygrade E6 who remain in paygrade E6, the number of personnel in paygrade E6 who are promoted to E7, etc. The personnel data matrix based on 1981 DMDC data is shown in Table 11. Also shown is a column of personnel losses during the year. Although the losses are not a part of the matrix, they are the basis for loss rates used in the matrix adjustment process developed later in this section. It should be noted that the personnel figures in Table 11 do not sum to the 1981 end strengths; accessions during the year are not included and the data are a summation of mental category specific data, such that personnel lacking a mental category identifier in the data base are excluded.

The Q matrix is a fractional flow matrix which describes the movement of personnel in terms of the fraction of personnel starting in a particular paygrade who end the year in a given matrix element. For example, if 42,459 personnel begin the year in paygrade E6 and 32,446 remain in paygrade E6, Q matrix element q_{44} will have a value of .765 (32,446 ÷ 42,439 = .765). These fractional flows are also known as continuation rates, and are referred to as

TABLE 11

Navy Active Duty Enlisted Personnel Data Matrix for 1981

BEGINNING PAYGRADE	ENDING PAYGRADE E1-3	E4	E5	E6	E7	E8	E9	LOSS
E1-3	76,747	42,302	452					28,410
E4	2,202	35,738	23,569					22,748
E5	122	628	38,144	10,101				12,744
E6			163	32,446	4,976			4,817
E7					14,768	1,533		2,544
E8						4,238	565	916
E9							1,907	475

Source: DMDC

such in subsequent discussion. The Q matrix is shown in Table 12, along with each paygrade's loss rates, determined in the same manner as the continuation rates.

In order to validate the Q matrix in the transitional flow model, a feasibility run was made using actual 1980-1981 data. The initial stocks were the DMDC by-paygrade end strengths for FY 80 and the recruitment vector was based on the quantity and by-paygrade profile of FY 81 prior service accessions provided by OP-01. The resultant computed FY 81 end strength was 473,051, which was 2,867 or .6 percent more than the DMDC FY 81 end strength of 470,184. In light of the degree of uncertainty inherent in many of the assumptions and operations of the overall process, this error, probably due to the 7 x 7 paygrade-by-paygrade matrix compression (aggregated over length of service), was considered acceptable.

The Q matrix, as calculated, is satisfactory for use in the transitional flow model, if 1981 conditions are desired in calculations for future years. Retention rates in 1981 were 42%/57%/94%, and presumably are reflected in the matrix. It is useful, though, to be able to make incremental changes in the continuation rates in order to produce a matrix reflecting a different set of retention rates, such as the POM 83 projected rates of 47%/67%/98%. With reference to the matrix and loss column, then, such an increase in retention rates would be reflected in a reduction

TABLE 12

Navy Enlisted Fractional Flow (Q) Matrix for 1981

ENDING PAYGRADE

BEGINNING PAYGRADE	E1-3	E4	E5	E6	E7	E8	E9	LOSS
E1-3	.519	.286	.003					.192
E4	.026	.424	.280					.270
E5	.002	.010	.618	.164				.206
E6			.004	.765	.118			.114
E7					.783	.081		.135
E8						.741	.099	.160
E9							.801	.199

in the loss rates and an increase in the continuation rates. The problem becomes one of identifying which, and how much, of the loss rates and continuation rates are affected by a desired change in retention rates. Specifically, a set of incremental continuation rates is needed to correspond to a desired marginal change in the retention rates.

An apportionment technique was used to develop a table of incremental continuation rate changes for marginal changes in retention rates. The first step in the process was a determination of the amount of the loss rate subject to change from changes in retention. An interesting property of an N x N matrix is its ability to provide through a matrix inversion procedure, the average "lifetime" of an individual in a given class or paygrade. Within that lifetime, there is only one year in which the continuation decision is made and, therefore, only that one year in which the loss rate is impacted. Consequently, the amount of loss rate subject to changes in retention is the paygrade loss rate divided by the lifetime. For 1981, in paygrade E4, that amount is .270 per year divided by 1.811 years or .149. That is to say that, if every E4 eligible to make a decision to continue service in a given year decided to continue, .149 of the loss rate would be shifted to the matrix elements and the .121, i.e., (.270 - .149), remaining would reflect losses unaffected by retention, i.e., attrition during the lifetime in paygrade when not at a decision point. The same

procedure was applied to the respective loss rates in the other paygrades.

In the next step, an assumption was made as to the length of service (LOS) at which the continuation decisions are made. The first and second term decisions are assumed to be at the four and eight year LOS points, respectively, and career decisions are assumed to be at the twelve and sixteen year LOS points. However, as retention rates are associated with paygrades in the matrix, a conversion between the LOS decision points and the proportions of different paygrades making those decisions was necessary. That conversion was accomplished by means of a paygrade by LOS table prepared by NPRDC, listing 1976-1977 retention rates and number of deciders for each LOS-paygrade cell. [Ref. 9] From these data, it was possible to approximate the proportions of personnel in each paygrade making a specific decision, recognizing that multiple paygrades may be involved in a specific decision, and that multiple decisions may be made within a specific paygrade.

Finally, these proportions were applied to that part of the loss rate, subject to retention decisions, for each paygrade. The applicable part of the loss was apportioned across the difference between the 1981 retention rates reflected in the matrix and 100% retention. For ease of manipulation, the incremental changes were only to be applied to the diagonal elements of the matrix, where individuals

remain in their beginning paygrade at the end of the year. These elements account for the majority of the cases. The result is Table 13, showing the incremental change in a particular diagonal matrix element as a result of a one percent change in a retention rate. These figures can be used to adjust the matrix to simulate the effect on the system of any desired set of retention rates.

2. End Strength Requirements

As mentioned earlier, the end strength requirements are primarily the authorization figures from the Enlisted Programmed Authorizations. The aggregate figures were used in the Baseline and Petty Officer Shortfall scenarios, and are found in Table 8. The quality scenario addresses only mental category I and II personnel and the end strengths are derived from the authorization figures from the Enlisted Programmed Authorizations for the highly technical ratings. The Quality scenario addresses both the case where the growth in the highly technical ratings follows the Navy-wide growth and the case of an accelerated growth in the highly technical ratings. The projected end strength requirements for both cases of the Quality scenario are listed in Table 14.

3. Beginning Inventories

The beginning inventories or stocks, for each year, in each scenario, are simply the end strengths from the previous year. The computer program used for scenario calculations automatically carries over a year's end

TABLE 13

Incremental Continuation Rate Changes for Q Matrix Adjustment

(Figures are continuation rate changes in designated matrix elements as a result of a 1% change in a specific retention rate.)

Q matrix element	(Paygrade)	Retention: First term	Retention: Second term	Retention: Career
q_{22}	(E4)	.004	.0004	--
q_{33}	(E5)	.003	.0006	--
q_{44}	(E6)	--	.002	.004
q_{45}	(E7)	--	--	.006

TABLE 14

Projected End Strength Requirements for the Highly Technical Ratings

Year	Accelerated Growth Rate	Navy-wide Growth Rate
1982	79,491	76,767
1983	86,390	78,325
1984	91,210	83,614
1985	96,283	85,678
1986	100,269	86,854
1987	104,509	89,190
1988	108,800	91,525
1989	113,164	93,862
1990	117,599	96,201

Sources: Enlisted Programmed Authorizations and Authors

strengths as the beginning inventory for the following year.

4. Recruitment Vector

The recruitment vector for both the Baseline and Petty Officer Shortfall scenarios is adjusted each year to produce 12,000 prior service accessions. For the Quality scenario, the prior service figure is 4,000, reflecting the 1981 proportion of prior service accessions for mental categories I and II.

5. Accessions

Accessions figures for each year are the unconstrained output of the transitionay flow model given the values of the model's other elements, e.g., end strength, transition matrix, and recruitment vector. Annual values for each scenario's end strengths, recruitment vector, accessions, and retention rates reflected in the matrix are listed in Appendix B.

B. BASELINE SCENARIO

Considerable thought has been given by manpower planners to the factors affecting the manning of a growing Navy. Various projections and policy statements have been the result of that thought. The Baseline scenario projects accession requirements and supply adequacy based on certain of these policy constraints and predictions.

The Q matrix was adjusted to reflect POM 83 retention goals of 47%/67%/98% for all calendar years. Prior service

accessions were held constant at 12,000 annually. End strength requirements were the figures listed in Table 3. The estimates of accessions required produced by the model range from a low of 94,690 in 1982 to a high of 111,387 in 1983, the year of the greatest increase in end strengths. Most accession figures were between 100-105,000 which compares favorably with 1981's 104,000 actual accessions.

The values for the explanatory variables in the enlistment supply model were generally in keeping with official projections. The 1981 relative pay ratio was held constant at 183, and the unemployment rates used are the Congressional Budget Office (CBO) baseline or most likely rates. Although POM 83 envisions a constant number of recruiters through the 1980's, the authors felt that a growth in the number of recruiters, at least consistent with Navy force growth, was reasonable. A fifty recruiter increase per year was assumed. Based on these assumptions, the enlistment supply model predicts an available 70,700 mental category I, II and III NPS males in 1982, but a sharp decline, thereafter, to 54,400 in 1990.

The sharply declining number of upper mental category NPS male accessions poses a great problem in filling the total accession requirements with quality personnel. As mentioned above, prior service male accessions are limited to 12,000 each year. Women accessions are held constant at 10,400. After the application of quality NPS male, prior

service and women figures to the total accession requirements, 1982 is the only year in which the remaining requirements are filled with an acceptable number of mental category IV NPS males. By 1990, mental category IV NPS males will be required to fill 29.2% of the requirements, 9.2% above Congressional limits. The assumptions employed in this scenario are summarized in Table 15, and the results in Table 16.

In 1981 there was a 22,000 petty officer shortfall. The assumptions and conditions driving the baseline scenario are able to reduce, but not eliminate, the petty officer shortage. With the exception of prior service by-paygrade structuring, there is no direct attempt to direct or control the magnitude of the petty officer shortage. The shortage declines to 14,318 by 1990, as shown in Table 17. Incidental to the system performance in this scenario is the first termer/career mix, which shifts from 59/41 in 1982 to 56/44 in 1990. Such a career mix shift can have positive effects, as will be noted in Chapter IV.

C. PETTY OFFICER SHORTFALL SCENARIO

As mentioned, the Navy experienced a 22,000 shortfall in the top six paygrades in 1981. This shortfall results in a less experienced force, more demanding working conditions for those covering the work requirements, and many billets being filled with nonrated personnel. In the

TABLE 15

Baseline Scenario - Basic Assumptions

	81	82	84	86	90
General Unemployment	8.9	8.9	7.4	6.9	6.5
General Unemployment (Improved Economy)	8.9	8.0	6.0	5.0	5.0
Recruiters	3490	3540	3640	3740	3940
Eligible Population (000) NPS Males Aged 17-21	1996	1963	1837	1733	1681
Relative Mil/Civ Pay Ratio (Avg. First Year BMC/AVG. Annual Civ. Pay)	.83 - - - - - - - -	- Held Constant - - -	- - - - - - - - -		
Prior Service Accessions	12.3	12.0	12.0	12.0	12.0
Women Accessions	9.7	10.4	10.4	10.4	10.4
Women Requirements	34.3	36.7	43.0	45.0	45.0
Retention Rates (1st/2nd/Career)	47/67/98 - - - - - -	-Held Constant - - -	- - - - - - - - -		

TABLE 16

Baseline Scenario - Accessions:
Baseline vs. Improved Economy

ACCESSION REQUIREMENTS

	Authorizations	NPS Male I, II, IIIA		Prior Service	Women	NPS Male IIIB/IV		Total
	(000)	(000)	(%)	(000)	(000)	(000)	(%)	(000)
1982								
Baseline (8.9)* Economy	480	51.1	(54)	12.0	10.4	19.6/1.6	(2.0)	94.7
Improved (8.0) Economy	480	47.8	(50)	12.0	10.4	18.4/6.1	(7.0)	94.7
1986								
Baseline (6.9) Economy	534	39.1	(38.5)	12.0	10.4	15.5/24.7	(24.0)	101.7
Improved (5.0) Economy	534	33.1	(32.6)	12.0	10.4	13.4/32.8	(32.0)	101.7
1990								
Baseline (6.5) Economy	560	37.3	(35)	12.0	10.4	15.1/30.9	(29.2)	105.7
Improved (5.0) Economy	560	32.6	(30.8)	12.0	10.4	13.5/37.2	(35.2)	105.7

*General unemployment rate

TABLE 17

Baseline Scenario - Petty Officer Shortfalls

PAYGRADE	PROJECTED SUPPLY 82	86	90	90 AUTHORIZATIONS
E-4	-1777	-3673	-8481	121,968
E-5	-9437	-5964	-7107	110,656
E-6	-10185	-10070	-4150	87,584
E-7	-753	+1828	+5106	37,800
E-8	-1466	-640	+353	11,592
E-9	-929	-547	-39	5,040
TOTAL SHORTFALLS	-20944	-19057	-14319	
TOTAL AUTHORIZATIONS (000)	480.1	534.1	560.0	560.0

Baseline scenario, it was apparent that POM 83 retention goals would be insufficient to eliminate the shortage by 1990. However, there is, presumably, some set of increased retention rates, perhaps as a result of pay or quality of life incentives, which will eliminate the shortage.

Accordingly, in this scenario (Petty Officer Shortfall Reduction), retention rates for each year are selected such as to produce a gradual reduction of the shortfall to eventual elimination in 1990. All other basic assumptions and conditions are the same as explained in the Baseline scenario. The controlling factors, then, are retention rates, reflected in the adjusted Q matrix, and the by-paygrade placement of the 12,000 prior service accessions by means of the recruitment vector. The prior service by-paygrade distribution appears in Appendix B. The recruitment vector is used to fill specific paygrade deficiencies and ease imbalances among paygrades.

Elimination of the shortfall required annual retention rates from a low of 47%/67%/98% to a 1983 high of 53%/70%/98%. These figures are not unreasonable, particularly as the former figures, POM 83 goals, appear in a different set of three years. With the exception of 1983, all other years required rates of 50%/70%/98%. The shortfall reduction in this scenario is shown in Table 18.

Aside from the shortfall reduction, all annual accession requirements were below 103,000, ranging between 89,000 and

TABLE 18

Shortfall Reduction Scenario - Petty Officer Shortfalls

	84	86	90	90
RETENTION RATES (1st/2nd/CAREER)	50/70/98	47/67/98	50/70/98	
		SHORTFALL		AUTHORIZATIONS
E4	+3617	-1900	-324	121,968
E5	-5753	-5395	-2707	110,656
E6	-9788	-6772	-4468	87,584
E7	-753	+3512	+6910	37,800
E8	-1466	-521	+766	11,592
E9	-929	-543	+44	5,040
TOTAL SHORTFALLS	-13,214	-11,619	+221	
TOTAL AUTHORIZATIONS (000)	480.1	534.1	560.0	560.0

103,000, with most between 95,000 and 100,000. However, this reduction in accessions is not enough to prevent an unacceptably high percentage of necessary mental category IV NPS males in the years from 1985-1990, with a high of 24% in 1990- These results are shown in Table 19. Finally, a career mix shift of 59/41 to 55/45 is also noted.

D. QUALITY SCENARIO

There has been increasing speculation that, as the Navy gets more technically complex, the requirement for personnel capable of performing successfully in the highly technical ratings will increase at a rate greater than the growth rate of Navy-wide requirements. This scenario examines a case in which the highly technical ratings' percentage share of the total end strength grows five percent, from 16% in 1982 to 21% in 1990. This scenario accepts the basic assumptions introduced in the Baseline scenario, with the exception of the end strength and prior service accession sizes. Additionally, an assumption is made that the mental category composition of the rating inventories in 1981 is reflected in the accessions, and that the percentage of mental category I and II personnel assigned to the highly technical ratings in 1981 will continue to apply. The ratings in the highly technical skill group are listed in Table 20.

The authorization figures for the highly technical ratings are taken from the Enlisted Programmed Authorizations

TABLE 19

Petty Officer Shortfall Reduction Scenario - Accessions

	82 (%)	86 (%)	90 (%)
END STRENGTH AUTHORIZATION (000)	480.1	534.3	560.0
NPS MALE ACCESSION MENTAL CAT. I, II & IIIA (000)	51.1 (58)	39.1 (40)	37.3 (38)
PRIOR SERVICE ACCESSIONS (000)	12.0 (13)	12.0 (13)	12.0 (12)
FEMALE ACCESSIONS MENTAL CAT. I, II, III (000)	10.4 (12)	10.4 (11)	10.4 (11)
NPS MALE ACCESSIONS MENTAL CAT IIIB (000)	15.3 (17)	15.5 (16)	15.1 (15)
NPS MALE ACCESSIONS MENTAL CAT. IV (000)	----	19.6 (20)	23.4 (24)
TOTAL ACCESSIONS REQUIRED (000)	88.8	96.6	98.2
RETENTION RATES (1ST/2ND/CAREER)	50/70/98	47/67/98	50/70/98

NOTES:

- Goldberg projects reduced reliance on Cat IV (increase Cat I, II and III) by 6.8K in 1986 and 8.1K in 1990.

- Retention requirements highest in 1983 at 53/70/98; other years remain at or below 50/70/98.

TABLE 20

Enlisted Skills Breakdown

Semi-Technical		Technical					Highly Technical	
AB	MS	AD	AW	DT	GSM	OM	AC	EW
ABE	PC	AF	AZ	EA	HM	OS	AE	FT
ABF	PN	AG	BU	EM	IC	OT	AQ	FTB
ABH	RP	AM	CE	EN	IM	PH	AT	FTG
AK	SA	AME	CM	EO	IS	PI	AX	FTM
BM	SK	AMH	CTA	EQ	JO	PM	CTI	MT
BT	SM	AMS	CTO	GM	LN	PR	CTM	ST
HT	YN	AO	CTR	GMG	ML	QM	CTT	STG
LI		AS	CU	GMM	MM	RM	DS	STS
		ASE	DK	GMT	MN	SW	ET	TD
Other		ASH	DM	GS	MR	TM		
NC		ASM	DP	GSE	MU	UT		
NA		AV						

Source: Deputy Chief of Naval Operations (Manpower, Personnel, and Training)

and increased yearly by an amount to achieve the desired growth. These end strengths are listed in Table 13. An annual 4,000 prior service accessions, E4 and above, reflect the percentage of prior service members accepted into the highly technical ratings in 1981. In 1981, 79.1% of the personnel in the highly technical ratings were mental category I and II. However, according to DMDC data, only 35.4% of the Navy's mental category I and II personnel were serving in the highly technical ratings.

The results of the computations are found in Table 21. With the exception of 1981, the annual requirements for mental category I and II NPS males exceed the number of accessions that would be allotted to those ratings under the 1981 distribution. In fact, in 1990, 74% of the mental category I and II accessions would have to be assigned to the highly technical ratings to satisfy the requirements. By way of comparison, if the growth of the highly technical ratings through 1990 was the same as the growth of the Navy in general, 64% of the mental category I and II NPS male accessions in 1990 would have to be assigned to the highly technical ratings to satisfy the requirements.

E. BASELINE SCENARIO IN AN IMPROVED ECONOMY

Heretofore, all the scenarios have been predicated on the moderate economic growth projected by the CBO. What would the accession projections become, and what would be

TABLE 21

Highly Technical Ratings - Requirements vs. Supply

Assumes current mental category composition in these ratings is maintained through 1990: I & II - 79.1%, III-A - 17.1%, IIIB - 3.8%.

	1982	1986	1990
MENTAL CATEGORY I AND II			
Requirement	10,466	13,410	15,926
Total Supply	30,615	22,908	21,521
Assigned Supply*	10,838	8,110	7,619
Surplus (Shortage)	372	(5,300)	(8,307)
MENTAL CATEGORY IIIA			
Requirement	2,262	2,899	3,443
Supply	20,488	16,191	15,802
MENTAL CATEGORY IIIB			
Requirement	503	644	765
Supply	19,595	15,499	15,140

*35.4% of Mental Category I and II were assigned to highly technical ratings in FY 81.

the resulting impact on the adequacy of supply, if there was a higher rate of economic recovery, as hoped for by the Federal Administration? Projected unemployment rates for a higher economic growth are specified in Table 15. The effect is fewer expected upper mental category NPS male accessions, as shown in Table 10. The results of the accession impact on the system under Baseline scenario conditions are detailed in Table 16. The most dramatic and disconcerting result is the requirement for mental category IV NPS males to fill 35% of the accession requirements in 1990.

IV. CONCLUSIONS

A. SUMMARY

As it is the Administration's policy to achieve a fifteen battlegroup Navy by 1990, it is imperative that thought be given to the manning of a force of that size, particularly in light of the declining pool of 17-21 year-old non-prior service individuals. In addition to the non-prior service pool, other potential sources of supply include prior service members, both Navy and other service, women, civilian substitution, lateral entry of civilians, retention of presently active duty sailors, and augmentation of the force with reserves. In view of current policy and for various political and practical reasons, women, non-prior service and prior service individuals, and retention are the manpower source areas considered to be the most desirable, and are, therefore, the focus of attention in the scenario projections.

The different 1982-1990 scenario projections appearing in this thesis are the product of the computerized manpower transitional flow model known as MAN-MOD, programmed for use with the Apple II microprocessing system. By means of MAN-MOD, the effects on total accessions and other variables can be simulated by the manipulation of such variables as retention rates and the number of prior service accessions.

In this way, enlisted force end strength strength by paygrade compositions, the number of prior service accessions, and retention rates can be determined.

In a baseline scenario, the enlisted manpower system was projected using current policy constraints on the utilization of women. Prior service accession numbers, retention rates, and economic projections through 1990 were also fixed in the baseline case. Manpower authorization figures for each year, prior service accessions of 12,000 per year, and POM 83 retention goals 57%/67%/98% first and second term and career retention rates were used to determine non-prior service male accession requirements, and the paygrade force profile for each year. With the exception of 1988, each year's non-prior service recruiting requirement was below the level of baseline year 1981. Petty officer shortfalls were reduced by over 6,000 to a figure of 14,318, with shortfall reduction in all paygrades except E4. A first termer/careerist ratio shift from 59/41 to 56/44 was noted. Though estimates of the non-prior service accessions were generally stable at approximately 90,000 throughout the time period, the dwindling non-prior service pool was responsible for a Rand model projection indicating a need for an unacceptably high number of mental category IV accessions, 29.2% of total accessions in 1990.

A second scenario focused on the petty officer shortfall, and actions necessary to eliminate it by 1990. The

numbers of petty officers in the force for any point in time is a function of, and can be most readily manipulated in the model by, retention rates, and allocation of prior service recruits by paygrade. In this scenario, retention rates were adjusted to levels sufficient to produce a steady reduction in the shortfall to an eventual elimination of the shortfall, in aggregate numbers, by 1990. The 12,000 prior service accessions were allocated in this manner in order to minimize imbalances between paygrades, both for a given year and for the entire process. Retention rates necessary to eliminate the shortfall fell in the achievable range of POM 83 goals of 47%/67%/98%, to a high of 53%/70%/98% for first term, second term, and career retention rates. Non-prior service accession requirements are as high as 90,000 in 1983, and between 76,000 and 86,000 for other years. Once again, the shrinking non-prior service pool is responsible for an unacceptably high mental category IV requirement input, predicted as 24% of the total accessions in 1990.

In recognition of the increasingly technical nature of the Navy and the concurrent greater need for technically skilled sailors, a third scenario focused on the ability of the Navy to provide sufficient personnel to man the highly technical ratings, given a five percent growth in these ratings' percentage share of the total enlisted force. Retention rates were set at POM 83 goals of 47%/67%/98% for

first term, second term, and career retention. A constant 4,000 prior service accessions, E4 and above, reflect the percentage of prior service accessions accepted into the highly technical ratings in 1981. In 1981, 79.1% of the personnel in the highly technical ratings were mental categories I and II, yet only 35.4% of the Navy's mental category I and II personnel were assigned to the highly technical ratings. The only year in which sufficient mental category I and II non-prior service accessions are projected to be available to meet requirements is 1982. Additionally, in order to meet the requirements that 79.1% of the personnel in highly technical ratings be mental categories I and II, as many as 74% of all mental categories I and II non-prior service accessions would need to be dedicated to the highly technical ratings.

Finally, although the Rand model indicates a rather bleak picture for mental category I, II, and III non-prior service accessions in the outyears, the prospects are even worse in the face of the improved economy hoped for by the Federal Administration. Under conditions of a realistically improved economy, up to 35% of total 1990 accessions may have to be filled by mental category IV accessions under the Baseline scenario.

B. POLICY IMPLICATIONS

The results of the scenarios point out three major challenges with regard to supplying the needed personnel

to man the Navy through 1990: (1) How to attract a sufficient quality and quantity of non-prior service male accessions and if not possible, (2) How to provide for the needs from alternative sources such as retaining more of those personnel currently in service, in which case there remains the challenge of, (3) How to retain sufficient numbers of quality sailors to counter the need for unavailable non-prior service males. Several issues having policy implications have been highlighted or implied by this thesis. The following is by no means exhaustive, yet addresses some of the more apparent issues.

1. <u>Attracting More Non-Prior Service Male Accessions</u>

A first step toward possible solutions lies in the Rand, CNA, and Duke models developed to project supplies of non-prior service males. These models indicate a positive correlation between certain variables and the number of expected accessions. Variables utilized include the number of recruiters in the field, dollars spent on recruitment advertising, military/civilian pay ratio, youth unemployment, and the size of the available population pool. Of these, the first two are within the control of the Navy, the third can be manipulated if DOD, Congress, and the President agree, while the latter two are largely exogenous and uncontrollable. Accordingly, the Navy could expect to see a positive marginal return in supply through increased fielding of recruiters and greater expenditures in advertising. Although it is

recognized that pay increases are not under its direct control, the Navy should continue to press Congress for pay policies which maintain or increase the military/civilian pay ratio. This can be accomplished through an indexing of military pay to some measure of civilian compensation, providing bonuses for enlistment, or making provision for a differential pay system based on skills which would provide comparable compensation for comparable civilian skills.

Though the Navy is incapable of controlling the country's general and youth unemployment, it should be able to take advantage of conditions of high unemployment when they exist. There should be some latitude in the accession goals whereby more accessions could be made when conditions permit, perhaps lessening the effects of the relative scarcity of other times.

Expenditures on CETA, a federal program, were found to be negatively correlated in the CNA model with non-prior service male enlistments. This program, along with other federal grants and loans for education, make post-high school training or education an attractive alternative to military service. In order to counter these negative influences, the Navy should encourage a National service obligation which could be tied to the acceptance of such assistance.

2. Alternative Sources of Personnel

Although numerous possible alternative sources of supply, from 30-45 year-old civilian lateral entry to immigrants, have been suggested, five sources show strong promise. Four, the use of women, contractor personnel, civilian lateral entry of younger civilians, and prior service personnel, are discussed below. The fifth, retention, will be discussed separately.

As mentioned earlier, the expanded use of women in presently authorized roles is constrained. However, a virtually unlimited supply of women makes them a prime source should the degree of scarcity of non-prior service males so warrant. Although presently unlikely, a possible lifting of statutory restrictions on women in combat roles and in certain ratings would expand their use, and ease the requirements for male accessions.

The current policies against increased federal hiring for the Civil Service effectively discount civilian substitution for military in various support and industrial positions as a potential aid in alleviating accession pressures. However, the same policies which downplay increased governmental participation favor increased private participation. Accordingly, where possible and less expensive than civilian direct hire, work at support and industrial activities currently performed by military personnel should be considered for contracting out to the private sector.

An additional cost of this approach which may have to be addressed is an increase in sea pay to those whose sea/shore rotation is shifted more to "sea" as a result of the elimination of military shore billets.

Much to its consternation, the Navy, for years, has been training its personnel for civilian employment, as the skills taught for their Navy employment are in many instances readily transferable to a marketplace where they draw a higher compensation. Consideration should be given to reversing the trend in part by accessing skilled civilians into comparable Navy skill areas at a paygrade entry level commensurate with their degree of skill and experience. The key to such a program is comparable or better compensation then received in the private sector. Implementation would follow the lines being pursued currently by LEAP, as discussed earlier. Sufficient need to pursue this path of accessions would have to be determined as to overcome two major objections: those of service members who had to work their way up through the ranks, and those of civilian employers who find their people being actively recruited by the Federal Government. Presumably, there would be no objection to active recruiting of fresh graduates of vocational or trade schools, and these should be considered prime targets.

Prior service accessions is the category of lateral entry possessing the greatest potential impact in alleviating

the need for non-prior service male accessions. Fewer individuals will have to be accessed and grown to fill midgrade positions if these positions can be filled directly with individuals who already possess the necessary training and service experience. The prior service accession is particularly valuable because of the expense and time saved as compared to what would be necessary to train a recruit into the position. Although more than 12,000 prior service members entered the Navy in 1981, the Navy can undoubtably do better in prior service recruiting. Currently, prior service accessions are considered along with non-prior service accessions, to be part of the "One Navy" goal, with no separate goals established for the two categories. As such, a recruiting unit might make all or none of its goal with prior service accessions. In essence, there is no prior service recruiting management other than the establishment of a Navy-wide ceiling of approximately 12,000. Two actions can and should be taken. Firstly, prior service goals should be divorced from non-prior service goals, and the prior service goals carefully managed to get the appropriate individuals to fill critical deficiencies. Secondly, prior service ceilings should not be fixed at some arbitrary figure through the outyears, but rather should be flexible in order to be responsive to market conditions, perhaps incorporating the concept of "loading up" when recruitment conditions are favorable.

3. Retention

Closely related to the recruitment of prior service members with training and experience is the idea of retaining them in the Navy in the first place. Once again, if the experienced petty officers are in place, where required (paygrades and ratings), there is less need to grow recruits to replace them. The key, then, is to retain the experienced people. A differential pay system is considered necessary. The Navy will have to provide compensation competitive with what the individual will be offered for his talents in the marketplace. Love of Navy life does not often overcome a several thousand dollar disadvantage in annual wage, and frequently more demanding working conditions. Quality individuals realize their worth and recognize the ludicrous nature of the common rebuttal to recommendations of differential pay -- "We're all equal in risking our lives to defend the country and should be paid the same for that risk." The fire control technician working fourteen-hour days to keep a radar operating while on station in the Indian Ocean, knows the difference in effort expended between himself and a mess specialist.

Competitive compensation needs to be in tangible forms such as basic pay, sea pay, reenlistment bonuses, vested retirement, and professional pay, rather than in the softer fringe benefits such as commissary privileges and CHAMPUS, which are intended to provide current "comparability."

Surveys have shown that few enlisted personnel have a clear idea of the concept of Basic Military Compensation (BMC), and will invariably underestimate the value of their compensation. [Ref. 10]

Additionally, once the matter of compensation is under control, a policy might be established to counter the "Greener Pastures Syndrome." If the member still desires to take a look at opportunities in the civilian environment, the Navy could provide him with a ten day to two week leave period some time during the last year of his first enlistment in order for him to see what opportunities are actually available. If he then desires to get out, he at least recognizes the Navy cares about him and his career and may stand a better chance of returning as a prior service accession if he becomes disillusioned with life on the outside. If he decides to remain, he is made aware that the Navy cares, and the purpose of being able to retain him will be served. This idea could at least be the subject of an experimental program.

An additional benefit to be derived through retention is a shift in the first term/career mix. More experienced people can, on the average, do more work and more efficiently than those less experienced. Thus, the same amount of work can be done with a reduced force, which would require fewer accessions to maintain it.

4. Efficient Management of the Current Force

The look taken at the quality mix in the Navy points out a situation with policy implications unrelated to the other three areas discussed previously. Navy systems are becoming increasingly technical, and the pressures to get quality people into the highly technical ratings will mount. Yet in 1981, only 35.4% of mental category I and II personnel in the force were assigned to the highly technical ratings. The policy implications are clear: Recruiting management must make every effort to make rating classifications consistent with the individual's ability. Furthermore, quality individuals in other than highly technical ratings should be offered encouragement and incentives to make the lateral conversion to a highly technical rating. A policy of alteral conversion must be consistent with the need to maintain a percentage of quality personnel in each rating for leadership and supervision.

C. AREAS FOR FURTHER STUDY

A study of a subject as broad as the manning of the Navy will leave areas alluded to, but untreated, topics addressed in a general fashion, but not detailed, and questions of whether another approach to an area might be more suitable than the one employed. The following are some areas considered worthy of further study.

The unconstrained billet requirements for the enhanced force were generated from SMD and SQMD data for the units

envisioned as making up the fifteen battlegroup Navy. For a more accurate look at the Navy of the future it would be beneficial to incorporate data provided by the HARDMAN project office. Such data would be especially useful in generating requirements for personnel in the highly technical ratings.

The central element of the manpower transitional flow model is the transition matrix. The matrix used in this study was constructed from data from FY 81 and describes the movement of personnel through the system during that year. As such, conditions peculiar to that year, such as high unemployment, and expectation of the October 1981 pay raise, are reflected in the matrix, and may have a substantial enough impact as to invalidate, or at least make questionable, the use of the matrix for any other year. A representative matrix reflecting longitudinal data over several years of stable conditions would probably provide a better basis for computation.

Because of the constraint placed on the matrix by the capability of the microprocessor used (limited to a 9 x 9 format), the matrix elements reflect a paygrade to paygrade transition. The use of paygrades, due to its compression, is less precise than the more common length of service (LOS) approach. This is particularly true when assumptions have to be made about promotion points for use in the adjustment of the matrix to reflect differing retention rates. If

computer capability allows, the LOS convention should be used. However, it is believed that the use of paygrades alone provides sufficient accuracy for the testing of certain of the aggregate impacts of policy changes.

The key to simulating the effects of differing retention rates is the process of adjusting the elements of the transition matrix. For simplicity of operation, the proportional allocation method used in this study made all changes to the diagonal elements of the matrix, those elements accounting for most of the affected personnel. In reality, some changes would also take place in adjacent off-diagonal elements. However, as a change to an off-diagonal element would lessen the change to the diagonal element, the net effect as compared to diagonal-element-only manipulation is uncertain. This crucial matter of matrix change is considered a high priority for further study.

One further recognized deficiency concerning the matrix is its use in the computations regarding manpower for the highly technical ratings. The matrix reflects the behavior of the aggregate force. Presumably, the behavior of the highest technical ratings, though probably similar, would be different. Longitudinal and by-rating continuation data would be preferable.

One of the most important aspects of this study is the potential for linkages with various manpower models. The only one addressed in detail has been the enlistment supply

model. For reasons stated earlier, the Rand model was the model utilized. All of the supply models should be viewed with reservations as they were developed when unemployment was lower, the military/civilian pay ratio was much lower, college loans and grants were plentiful, and the ASVAB was misnormed. The CNA model is the one most recently updated, and, if the data used in its development are available, it should be favored in consideration for use in further efforts.

Models addressing the cost to the government and to the individual of decisions discussed in this study are a fertile area for further research. Aspects of the retention decision, such as replacement costs, reenlistment cost, and those addressed by the Annualized Cost of Leaving (ACOL) model, should be considered. The use of alternative sources of supply such as the expanded use of women, civilian substitution, and contracting will impact on sea/shore rotation. What will be the required effect on sea pay? The monetary effects of various decisions need to be looked at in the context of the whole, not just with regard to the immediately affected group, but to the Navy manpower system.

As revealed in the results of the scenarios, the system itself is currently driving itself toward a higher career mix. Is this trend good? There is reasonable logic behind the idea that more experienced personnel are more productive. However, some effective measures of productivity must be

brought into play in order to make decisions as to the desirability of driving the system to a higher career mix.

A good part of a sailor's service time is spent in training. Any decisions or outcomes affecting accessions, attrition, or retention should be validated with regard to training pipelines. Models such as Simulation Language for Alternative Modeling (SLAM) can be employed to that end. [Ref. 11]

The purpose of this study has been the examination of manning the Navy during the 1980's. However, the Navy does not operate in a vacuum in seeking its resources. The other services must solve their manning problems as well. The Air Force will also be growing during this time period. The Air Force has always been an attractive competitor, especially in the recruiting of top quality people. The Army and Marines, while not expected to grow as dramatically in end strength, are also trying to improve the overall quality of their forces. An examination of the other services' personnel requirements and their impact on the Navy is an important and overdue project.

Finally, the focus of this study has been the enlisted manning of the fifteen battlegroup Navy. Officer requirements will also grow and the subject of their procurement and retention should likewise be addressed.

APPENDIX A

A SAMPLE CASE, STEP-BY-STEP

The Manpower Transitional Flow Model MAN-MOD, in its adaptation for use with Apple II microprocessor, is the key computational vehicle for the results presented in this thesis. The Apple program is user friendly, straightforward and lends itself to numerous approaches to the Manpower System Flow problem. The purpose of this appendix is to take the reader step-by-step through the sequence of inputs and operations necessary to perform the calculations used to obtain the results presented in Chapter III. The steps presented are only those necessary for the specific calculations performed and, therefore, ignore numerous other options contained in the program. For a complete explanation of the Apple MAN-MOD program, its capabilities, and use, see "An Apple II Implementation of the MAN-MOD Manpower Planning Model," in the list of references at the end of this thesis.

A. Entry of Initial Data

The scenario which is demonstrated in the entry of initial data section is the Baseline scenario. Though many of the entries for the three scenarios are the same, dissimilar entries are noted as they appear.

1. The program is initiated by: (a) placing the MAN-MOD program disk in disk drive 1, (b) turning on the

video monitor, (c) turning on the printer, (d) turning on the computer (switch on the left hand side on the back). On the screen will appear:

MAN-MOD IS
AN APPLE ADAPTATION OF
BARTHOLOMEW AND FORBES'
"BASEQN" - A MARKOV TRANSITION MODEL.

2. After a brief pause, a terminology review appears on the screen as shown in display 1. As directed at the bottom of the screen PRESS RETURN TO CONTINUE.

```
       * MAN-MOD TRANSITION MATRIX PROGRAM *

                (TERMINOLOGY REVIEW)
                --------------------

   (A) ACCEPT:    ACCEPT SCREEN DISPLAY, PRO-
                  CEED TO NEXT ROUTINE

   (E) ESCAPE:    ABORT PRESENT ROUTINE, RE-
                  TURN TO MENU

   INPUT:         CALLS FOR A DATA INPUT,
                  ONCE ENTERED PRESS RETURN

   PRESS:         SELECT CHOICE OF SCREEN OP-
                  TIONS, AND PRESS CHOICE

   (R) REENTER:   RE-INPUT VALUES DISPLAYED
                  ON SCREEN

   . . . . . . . . . . . . . . . . . . . . . .

              PRESS RETURN TO CONTINUE
```

DISPLAY 1

3. The next statement is that of "MAN-MOD PROGRAM BEING LOADED." The program loading takes about 25 seconds.

4. The Main menu shown in Display 2 appears. Selection 1 will not be discussed as a knowledge of the Markov Chain Transitional Flow Model is assumed. Selections 3 and 4 are discussed later. Select option 3 to enter MAN-MOD OPERATIONAL MODEL.

```
       * MAN-MOD TRANSITION MATRIX PROGRAM *

                  (MAN-MOD MENU)
                  --------------

          (1) MAN-MOD THEORY & DEFINITIONS

          (2) MAN-MOD OPERATIONAL MODEL

          (3) SAVE DATA FILE TO DISK

          (4) EXIT MAN-MOD PROGRAM


       . . . . . . . . . . . . . . . . . . . .

                 PRESS SELECTION
```

DISPLAY 2

5. From the MAN-MOD OPERATIONAL MODEL menu select option 1, INPUT NEW DATA. Selections 2 through 5 are mentioned later; Selection 6 returns the user to the Main menu, display 2.

6. The INPUT NEW DATA Selection permits the creation of a new data file. The user is prompted for each entry and

```
* MAN-MOD TRANSITION MATRIX PROGRAM *

      (1) INPUT NEW DATA

      (2) RECALL DATA FROM DISK

      (3) CHANGE OR MODIFY PARAMETERS

      (4) LIST INPUTS OR PARAMETERS

      (5) CALCULATE WITH CURRENT DATA

      (6) RETURN TO MENU

. . . . . . . . . . . . . . . . . . .

          PRESS SELECTION
```

once the entry is made, it appears on the screen for verification. The user then has the choice of : (R), reentering the data, if incorrect, (A), accepting the entry, or (E), escaping to the MAN-MOD OPERATIONAL menu, display 3.

The first entry is FILE NAME. This entry is limited to 15 characters, the first of which must be a letter. An example entry is:

BASELINE.

7. The NUMBER (K) OF CLASSES OR GRADES defines the size of the matrix. Classes utilized in these scenarios are paygrades E1-3 through E9 and the appropriate entry is:

7.

8. The INITIAL CLASS VECTOR (N) asks for a 7 x 1 vector which is the initial stocks or inventories by class. The program prompts for each element, in turn, by row and column (row 1, cols. 1-7). After each entry, pressing the RETURN key results in a prompting for the next entry.

	BASELINE & P.O. SHORTFALL	QUALITY
R1,C1	178,108	28,476
C2	99,533	15,914
C3	83,394	13,333
C4	66,292	10,599
C5	30,824	4,928
C6	8,606	1,376
C7	3,432	548

9. The program will next ask for the FRACTIONAL FLOW MATRIX, a row at a time (row 1, columns 1-7 through row 7, columns 1-7). The first entries are:

R1,C1	.5190
C2	.2860
C3	.0300
C4	.0000
C5	.0000
C6	.0000
C7	.0000

	BASELINE	P.O. SHORTFALL	QUALITY
R1,C1	.8734	.8649	.7680
C2	.0833	.0950	.2320
C3	.0433	.0401	.0000
C4	.0000	.0000	.0000
C5	.0000	.0000	.0000
C6	.0000	.0000	.0000
C7	.0000	.0000	.0000

12. ADDITIVE NUMBER is the figure to be added to the previous end strength to achieve the desired end strength or system size.

BASELINE & P.O. SHORTFALL	QUALITY
9965	43.7

13. TIME (T) PERIODS TO INITIALLY CALCULATE is entered as 1. At least one change is made for each subsequent year and therefore all calculations are made a year at a time.

14. Selection 3 or PERCENTAGE OPTIONS FOR PRINT OUT provides a percentage figure next to the end strength classes indicating the percentage of the end strength entry relative to the corresponding entry for initial stocks in the original period. Selection 3 is utilized in all scenarios.

15. At this point initial data entry is complete and the screen will display "INITIAL INPUTS COMPLETE." The user will then be given the option to save the new file if desired. Saving the file is generally a good idea in order to preclude data loss. A "yes" choice will bring a "DATA BEING SAVED" to the screen and then return the user to the MAIN menu, display 2. Once the file is saved it can later be recalled from the disk into the computer using option 2 of the MAN-MOD OPERATIONAL MODEL menu, without having to reenter the data (see display 3). Option 4 of the MAN-MOD OPERATIONAL MODEL menu will provide a data listing of all initial inputs as shown in figure A-1.

B. Changing Data

1. When performing calculations from year to year it is necessary to change certain of the data elements entered in the initial input. This is easily accomplished by selecting option 3 of the MAN-MOD OPERATIONAL MODEL menu, CHANGE OR MODIFY PARAMETERS. The CHANGE OR MODIFY DATA menu, display 4, will appear.

```
              * MAN-MOD TRANSITION MATRIX PROGRAM *

                    (CHANGE OR MODIFY DATA)
                    -----------------------

        (1) FILE NAME              (7) PERCENT (%)
        (2) INITIAL STKS           (8) EXT RANGE +T
        (3) MATRIX (P)             (9) (P) ELEMENT
        (4) RECRUITMENT           (10) (P) ROW
        (5) OPTIONS               (11) RESET STKS
        (6) TIME (T)              (12) RETURN MENU

              * GOTO THEORY FOR EXPLANATIONS *

        . . . . . . . . . . . . . . . . . . . .

                       INPUT SELECTION
```

MAN-MOD DATA FILE LISTING

DATA FILE NAME IS....:	BASELINE
NUMBER (K) CLASSES...:	(7)
TIME (T) PERIODS.....:	(1)
PERCENTAGES OPTION...:	GRADE SIZE AS % OF ORIGINAL SIZE
OPTION SELECTED IS...:	ADDITIVE (SYSTEM SIZE)
OPTION INPUTS........:	CALCULATES TOTAL NET NUMBER TO INCREASE SYSTEM BY (9965)

INITIAL STOCK (N) VECTOR AND RECRUITMENT (R) VECTOR

	COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7
VECTOR N:	178103	99533	83394	66292	30824	8606	3432
RECRUIT R:	.8734	.0833	.0433	.0000	.0000	.0000	.0000

TRANSITIONAL FLOW MATRIX (P)

	COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7
ROW (1)	.5190	.2860	.0030	.0000	.0000	.0000	.0000
ROW (2)	.0260	.4480	.2800	.0000	.0000	.0000	.0000
ROW (3)	.0020	.0100	.6290	.1640	.0000	.0000	.0000
ROW (4)	.0000	.0000	.0040	.8010	.1180	.0000	.0000
ROW (5)	.0000	.0000	.0000	.0000	.8070	.0810	.0000
ROW (6)	.0000	.0000	.0000	.0000	.0000	.7410	.0990
ROW (7)	.0000	.0000	.0000	.0000	.0000	.0000	.8010

FIGURE A-1

2. Of the twelve options in the CHANGE OR MODIFY DATA menu, four of them are of particular concern. Option 4, RECRUITMENT, is changed each time as the system grows, in order to reflect the appropriate number of desired prior service accessions. Option 8, EXTEND RANGE + T, is changed to extend the calculation time horizon one more year. For example, an input of "3" would extend calculations one year beyond current calculation year T + 2 and would be the third year after the original input year T. Option 9, (P) ELEMENT, can be used to change an individual element in the transition matrix, by entering its row, column designation, eg., R2,C2. When the old element entry is shown, an opportunity is provided to insert the new entry. This option is necessary for making changes to the matrix which reflect desired retention rates for a particular year. Finally, option 12, RETURN MENU, returns the user to the MAN-MOD OPERATIONAL MODEL menu, display 3, from which calculations can be initiated using option 5, CALCULATE WITH CURRENT DATA.

C. Baseline Scenario Procedures

The baseline scenario examines the case where system size grows annually, while retention is held constant at POM 83 goals of 47%/67%/98%, and prior service accessions are a constant 12,000 annually. Three changes are made from year to year.

1. The calculation time horizon is extended one year. For 1983 the input is

INPUT + T = 2 .

2. The recruitment vector is changed to provide 12,000 prior service accessions. As the total accessions required each year are rarely the same, the current year's vector will not provide 12,000 prior service accessions in the calculations for the following year; an increase in accession level is accompanied by too many prior service accessions, a decrease by too few. An acceptable accession distribution is most easily accomplished by assuming all accessions will be either class 1 or 2 (vector elements R1,C1 and R2,C2, with all others .0000). By making adjustments back and forth between these two elements and checking the results in calculations on the screen, a class 2 input of close to 12,000 can be achieved. For 1983 the recruit vector is:

R1,C1	.8923
C2	.1077
C3	.0000
C4	.0000
C5	.0000
C6	.0000
C7	.0000

And the output is:

CLASS	RECRUITMENT
1	99391
2	11997
3	0
4	0
5	0
6	0
7	0

Once the proper non-prior service/prior service balance is achieved, the non-prior service fraction can be distributed among classes 2 through 7 to fill petty officer billets as desired in order to balance deficits or load for future movement through the system. The recruit vector of:

R1,C1	.8923
C2	.0905
C3	.0172
C4	.0000
C5	.0000
C6	.0000
C7	.0000

yields an accession profile of:

CLASS	RECRUITMENT
1	99391
2	10081
3	1916
4	0
5	0
6	0
7	0

3. After the proper recruitment vector is accepted, the system increase entry appears for change and/or acceptance. For 1983 the system increase input is: 24725.

4. Return to MAN-MOD OPERATIONAL MODEL menu to initiate calculation for printout.

D. Petty Officer Shortfall Reduction Scenario Procedures

The petty officer shortfall reduction scenario seeks to determine the retention rates for each year necessary to produce a steady reduction in aggregate petty officer shortfall to its eventual elimination in 1990. Prior service accessions remain constant at 12,000, while the total system size grows. Four changes may be necessary each year.

1. The extended time range, recruitment vector, and system increase are treated as described in paragraph C above. Their values for 1983 are as follows:

(a) INPUT + T = 2

(b) RECRUITMENT VECTOR:

R1,	C1	.8834
	C2	.0958
	C3	.0000
	C4	.0208
	C5	.0000
	C6	.0000
	C7	.0000

Accession Profile:

CLASS	RECRUITMENT
1	90830
2	9850
3	0
4	2139
5	0
6	0
7	0

(c) SYSTEM INCREASE: 24725

2. The choice of retention rates for a given year is a function of the desired aggregate petty officer shortfall produced by them. The petty officer shortfall is determined by comparison of aggregate petty officer authorizations for the year and the calculated aggregate petty officer end strengths. Once an appropriate shortfall figure is decided, retention rates must be found that will produce it. Accordingly, trial and error adjustments are made to the matrix using the marginal rates from Table 13, Chapter III, until adjusted elements reflecting a certain set of retention rates are found which achieve the necessary calculated aggregate petty officer profile. The preferred retention rates for 1983 are 53%/70%/98%. The necessary matrix element changes are:

(P) ELEMENT:	R2,C2	.4610
	R2,C3	.6320
	R4,C4	.8070

Changes in retention rates alter the accession level and consequently necessitate adjustments in the recruitment vector. These are most appropriately made after adjustments to the matrix are complete.

E. Quality Scenario Procedures

1. The quality scenario examines the growth of the highly technical ratings, with retention and prior service accessions held constant at 47%/67%/98% and 4,000 respectively.

As in the baseline scenario, changes are made to the extended time range, recruitment vector, and system size. The values for 1983 are:

(a) INPUT + T = 2

(b) RECRUITMENT VECTOR:

R1,	C1	.8074
	C2	.1508
	C3	.0000
	C4	.0418
	C5	.0000
	C6	.0000
	C7	.0000

ACCESSION PROFILE:

CLASS	RECRUITMENT
1	16790
2	3136
3	0
4	869
5	0
6	0
7	0

F. Obtaining Results

1. As discussed earlier, option 12 of the CHANGE OR MODIFY DATA menu takes the user into the MAN-MOD OPERATIONAL MODEL menu from which option 5 iy chosen to initiate calculations.

2. Selection of option 5, CALCULATE WITH CURRENT DATA, brings to the screen the menu shown in display 5. Select from this menu option 3, EXTENDED CALCULATION RANGE.

3. The final choice is that of screen or printer readout of the results.

4. Following the calculation phase the user is returned to the calculation menu, display 5. By selecting option 4,

```
* MAN-MOD TRANSITION MATRIX PROGRAM *

  (1) CALCULATE ALL Ø PERIODS
  (2) CALCULATE LAST TIME PERIOD Ø
  (3) EXTEND CALCULATION RANGE
  (4) RETURN TO MENU


. . . . . . . . . . . . . . . . . . . .

           PRESS SELECTION


              DISPLAY 5
```

RETURN TO MENU, the user is taken to the MAN-MOD OPERATIONAL MODEL menu whose option 6, RETURN TO MENU, places the user back in the MAIN menu. The user can then exit the MAN-MOD program by selecting option 4.

APPENDIX B

ANNUAL SUMMARIES

1982

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	177893	.8734	82703
2	104250	.0833	7888
3	86058	.0433	4100
4	66777	.0000	0
5	32697	.0000	0
6	8874	.0000	0
7	3601	.0000	0
TOTAL	480149	1.0000	94690

Shortfall Reduction

Retention 50%/70%/98%

Class	End Strength	Recruit Vector	Recruitment
1	171971	.8649	76780
2	106090	.0950	8434
3	89742	.0401	3560
4	67174	.0000	0
5	32697	.0000	0
6	8874	.0000	0
7	3601	.0000	0
TOTAL	480149	1.0000	88774

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	28450	.7680	13231
2	19404	.2320	3997
3	13739	.0000	0
4	10676	.0000	0
5	5228	.0000	0
6	1419	.0000	0
7	575	.0000	0
TOTAL	79491	1.000	17228

1983

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	194600	.8923	99391
2	108523	.0905	10081
3	86898	.0172	0
4	67602	.0000	0
5	34266	.0000	0
6	9224	.0000	0
7	3763	.0000	0
TOTAL	504875	1.0000	111387

Shortfall Reduction

Retention 53%/70%/98%

Class	End Strength	Recruit Vector	Recruitment
1	183021	.8834	90830
2	110112	.0958	9850
3	93376	.0000	0
4	71066	.0208	2130
5	34313	.0000	0
6	9224	.0000	0
7	3763	.0000	0
TOTAL	504874	1.0000	102819

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	32087	.8074	16790
2	20103	.1508	3136
3	14971	.0000	0
4	11674	.0418	869
5	5479	.0000	0
6	1475	.0000	0
7	601	.0000	0
TOTAL	86390	1.0000	20795

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	194790	.8832	90797
2	116451	.1100	11309
3	87468	.0068	699
4	68400	.0000	0
5	35630	.0000	0
6	9611	.0000	0
7	3927	.0000	0
TOTAL	516277	1.0000	102805

Shortfall Reduction

Retention 50%/70%/98%

Class	End wtrength	Recruit Vector	Recruitment
1	181585	.8743	83547
2	113882	.1030	9843
3	96367	.0000	0
4	74833	.0227	2169
5	36076	.0000	0
6	9614	.0000	0
7	3927	.0000	0
TOTAL	516285	1.0000	95559

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	33054	.7985	15848
2	22332	.2015	3999
3	16055	.0000	0
4	11806	.0000	0
5	5799	.0000	0
6	1537	.0000	0
7	627	.0000	0
TOTAL	91210	1.0000	19847

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	198192	.8866	93893
2	118286	.0900	9531
3	91834	.0234	2478
4	69133	.0000	0
5	36825	.0000	0
6	10008	.0000	0
7	4097	.0000	0
TOTAL	528375	1.0000	105903

Shortfall Reduction

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	186386	.8812	88990
2	115913	.1188	11997
3	98249	.0000	0
4	75745	.0000	0
5	37944	.0000	0
6	10046	.0000	0
7	4097	.0000	0
TOTAL	528381	1.0000	100987

Quality

Retention 47%/67%/98%

Class	End Rtrength	Recruit Vector	Recruitment
1	34849	.8103	17082
2	23618	.1897	3999
3	17390	.0000	0
4	12090	.0000	0
5	6073	.0000	0
6	1609	.0000	0
7	654	.0000	0
TOTAL	96283	1.0000	21081

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	195824	.8820	89704
2	112626	.0200	2034
3	99589	.0680	6916
4	73487	.0300	0
5	37875	.0000	0
6	10399	.0000	0
7	4272	.0000	0
TOTAL	534075	1.0000	101705

Shortfall Reduction

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	184585	.8759	84640
2	118200	.1240	10
3	100158	.0001	0
4	76785	.0000	0
5	39559	.0000	0
6	10518	.0000	0
7	4276	.0000	0
TOTAL	534081	1.0000	96633

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	35689	.8090	16953
2	23655	.1400	2934
3	18645	.0000	0
4	13605	.0510	1069
5	6328	.0000	0
6	1684	.0000	0
7	693	.0000	0
TOTAL	100269	1.0000	20956

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	195376	.8830	90616
2	115360	.0770	7902
3	100159	.0400	4105
4	75196	.0000	0
5	39237	.0000	0
6	10774	.0000	0
7	4451	.0000	0
TOTAL	540553	1.0000	102623

Shortfall Reduction

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	185487	.8780	86416
2	118754	.1220	12007
3	101940	.0000	0
4	77931	.0000	0
5	40985	.0000	0
6	10998	.0000	0
7	4466	.0000	0
TOTAL	540561	1.0000	98421

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	36903	.8160	17728
2	23902	.1340	2911
3	19476	.0000	0
4	15042	.0500	1088
5	6712	.0000	0
6	1760	.0000	0
7	714	.0000	0
TOTAL	104509	1.0000	21725

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	196295	.8842	91695
2	116421	.0758	7861
3	101337	.0400	4148
4	76658	.0000	0
5	40537	.0000	0
6	11162	.0000	0
7	4632	.0000	0
TOTAL	547043	1.0000	103704

Shortfall Reduction

Retention 50%/70%/98%

Class	End Strength	Recruit Vector	Recruitment
1	183846	.8754	84287
2	120811	.1246	11997
3	104369	.0000	0
4	79608	.0000	0
5	42271	.0000	0
6	11469	.0000	0
7	4666	.0000	0
TOTAL	547041	1.0000	96284

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	38207	.8213	18390
2	25458	.1787	4001
3	20110	.0000	0
4	15243	.0000	0
5	7192	.0000	0
6	1848	.0000	0
7	746	.0000	0
TOTAL	108800	1.0000	22391

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	197803	.8853	92696
2	117687	.0800	8376
3	101881	.0347	3633
4	78022	.0000	0
5	41759	.0000	0
6	11555	.0000	0
7	4815	.0000	0
TOTAL	553522	1.0000	104706

Shortfall Reduction

Retention 50%/70%/98%

Class	End Strength	Recruit !ector	Recruitment
1	184084	.8767	85318
2	121317	.1233	11999
3	106457	.0000	0
4	81360	.0000	0
5	43506	.0000	0
6	11922	.0000	0
7	4873	.0000	0
TOTAL	553520	1.0000	97318

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	39803	.8281	19274
2	26533	.1719	4001
3	20984	.0000	0
4	15508	.0000	0
5	7603	.0000	0
6	1952	.0000	0
7	780	.0000	0
TOTAL	113164	1.0000	23275

Baseline

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	199679	.8866	93755
2	113487	.0300	3172
3	103549	.0434	4589
4	83434	.0400	4230
5	42906	.0000	0
6	11945	.0000	0
7	5001	.0000	0
TOTAL	560000	1.0000	105747

Shortfall Reduction

Retention 50%/70%/98%

Class	End Strength	Recruit Vector	Recruitment
1	185139	.8778	86232
2	121644	.1222	12004
3	107949	.0000	0
4	83116	.0000	0
5	44710	.0000	0
6	12358	.0000	0
7	5084	.0000	0
TOTAL	560000	1.0000	98236

Quality

Retention 47%/67%/98%

Class	End Strength	Recruit Vector	Recruitment
1	41524	.8342	20134
2	26618	.1300	3138
3	21884	.0000	0
4	16727	.0358	864
5	7966	.0000	0
6	2062	.0000	0
7	818	.0000	0
TOTAL	117599	1.0000	24136

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